

# Capturing diversity in cancer incidence and outcomes among the New Zealand Pacific population using linked administrative data

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## ABSTRACT

**AIM:** The New Zealand population defined as “Pacific” is ethnically diverse, but this diversity is seldom examined in health research. This paper applies novel methods for describing health outcomes for specific Pacific populations in New Zealand using all-cancer and gastric cancer incidence and mortality as examples. Effects of loss to follow-up from leaving the country are also assessed.

**METHOD:** The New Zealand Cancer Registry was linked to administrative datasets and analysed within Stats NZ’s Integrated Data Infrastructure (IDI). All-cancer and gastric cancer incidence was examined over the 1995–2022 period, as well as 1–5-year mortality among 1998–2017 diagnoses.

**RESULTS:** There was variability in age-standardised all-cancer incidence and gastric cancer incidence for different Pacific groups. Less variation in mortality was identified between groups, and these rates increased only modestly when adjusting for those who left the country. Lower all-cancer mortality was observed in 2008–2017 compared with 1998–2007.

**CONCLUSION:** Variation in health outcomes among specific Pacific ethnicities is masked when examining Pacific peoples as an aggregated ethnic group. However, small counts among small ethnicities create challenges for producing detailed, reliable data when using the IDI.

New Zealand’s Pacific population count reached 442,632 in the 2023 Census, representing 8.9% of the total population and a 16% increase over the 2018 Census.<sup>1</sup> The Pacific population comprises several specific ethnicities, including Samoan, Cook Islands Māori, Tongan, Niuean, Tokelauan and Fijian ethnicities, which are categorised under “Level 2” of the Statistical Standard for Ethnicity.<sup>2</sup> Demographic differences between Level 2 Pacific ethnic groups include population size, migration histories and right of travel to and from New Zealand. Cook Islands Māori, Niueans and Tokelauans, for example, are much more likely to have been born in New Zealand and are also more likely to identify with multiple other ethnic groups.<sup>3</sup> This diversity drives explicit calls, such as from the Ministry for Pacific Peoples, for detailed analysis of outcomes for specific Pacific ethnic groups.<sup>4</sup>

This study addresses this need by examining cancer incidence and mortality by Level 2 Pacific ethnicity. Pacific peoples experience higher incidence rates of many cancers and lower survival than non-Pacific, non-Māori New Zealanders.<sup>5–10</sup> It is possible that cancer incidence and outcomes

vary by specific Pacific ethnicity,<sup>11</sup> but there is currently little research into this. We also examine the impact of outward migration on mortality estimates.

Movement of Pacific peoples between New Zealand and the island nations has often been raised as potentially inflating cancer survival estimates among the population.<sup>6,9,11–13</sup> Specifically, it is possible that Pacific peoples are more likely to leave the country to return to a home nation following a cancer diagnosis, meaning survival outcomes (potential deaths) may not be captured by the New Zealand administrative system. Prior research has estimated that this form of return migration could result in a 4–12% underestimation of deaths among Pacific peoples, and that return migration could be greater among Samoan and Tongan people due to more recent migration among these groups.<sup>11</sup> New Zealand citizens from Realm countries (i.e., Cook Islands, Niue and Tokelau) also have freedom of travel to New Zealand and are entitled to publicly funded New Zealand healthcare.<sup>14</sup> This could make this issue more likely among Realm country ethnicities (Realm ethnicity is used here to

refer to those with Cook Islands Māori, Tokelauan or Niuean ethnicity) who may receive a cancer diagnosis in New Zealand. However, there are currently no published data that quantify the scale of this type of migration and the impact on survival estimates.

We examined cancer incidence and mortality (all cancers and gastric cancer specifically) among the Level 2 Pacific ethnicities using Stats NZ's Integrated Data Infrastructure (IDI). The IDI is a collection of linked, de-identified administrative microdata about people and households from providers such as the Ministry of Health (MOH), Department of Internal Affairs (DIA) and Stats NZ (e.g., censuses).<sup>15</sup> We examined 1995–2022 cancer incidence (the full range of data available in the New Zealand Cancer Registry [NZCR] in the IDI) and 1–5-year mortality rates among those diagnosed during a 20-year period from 1998 to 2017. Gastric cancer incidence and mortality is relatively high among Pacific peoples compared with Europeans in New Zealand, and it was the sixth most diagnosed cancer from 2007 to 2019 among Pacific peoples.<sup>6</sup> Yet counts of gastric cancer cases are relatively low. It is, therefore, both an important cancer to monitor with the Pacific population and a useful demonstration on the potential possibilities and limitations of reporting on small counts of specific cancer diagnoses within smaller specific Pacific populations—particularly when using the IDI.

The key benefit of the IDI is the ability to link the NZCR to other administrative datasets to expand the scope of available information that is not routinely collected in the NZCR. In particular, here we link the NZCR to New Zealand border movement data to quantify the level of emigration from New Zealand following diagnoses. This enables us to examine mortality rates when adjusting for those departing the country without return. However, confidentiality requirements when using IDI data, including suppression of counts below 6 and random rounding of counts to base 3, pose challenges when examining small population outcomes, which we demonstrate here.

Overall, our aims were to: a) examine variation in age-standardised cancer incidence (all cancers and gastric cancer) for those of Level 2 Pacific ethnicity, b) capture diversity in all-cancer and gastric cancer mortality for Level 2 Pacific ethnicities, c) quantify the amount of outward migration from New Zealand among Pacific peoples diagnosed with gastric cancer, and the extent to which this impacts mortality estimates, and d) demonstrate the extent of error in Pacific mortality estimates

created by the random rounding requirement for IDI data.

## Method

### Study population

We analysed Pacific peoples' first recorded diagnosis (any cancer, then gastric cancer specifically; International Classification of Disease [ICD] 10 codes C16-C169) in the cancer registry between 1995 and 2022 for incidence and 1998 and 2017 for mortality. Diagnosis date ranges for mortality estimates were based on data availability in the required collections in the IDI.

### NZCR and IDI data sources

The NZCR contains information on all cancers first diagnosed in New Zealand, with diagnosis records from 1995 to 2022 available in the October 2023 refresh of the IDI. Ethnicity information is included to Level 2 in the NZCR, and ethnicity records are periodically updated. Up to three ethnicities are listed per person if they are present in at least 20% of a person's records across the National Health Index, mortality collection and hospital discharge data collections.<sup>16</sup>

For this study, we supplemented and expanded existing NZCR records with IDI data. For incidence rates among the population, we used the administrative population census (APC) as our source of denominator population counts. The APC is available within the IDI and is an estimated resident population based on activity in administrative records.<sup>17</sup> Ethnicity in the APC is coded using a source ranked approach, where the highest quality available source was used to code ethnicity. We used the 30 June 2008 APC for the denominator year for all years of gastric cancer diagnoses, as it is the midpoint of the study period. As such, incidence reflects both previous diagnoses made prior to the denominator date to 1995 and future diagnoses made following the denominator date to 2022. A total response approach to ethnicity coding was used, such that each individual was counted for each of their ethnic group affiliations. As such, ethnic groups in this study are not independent.

For mortality rates, Level 2 ethnicity information was updated using an “ever recorded” approach for records across the NZCR, 2013 and 2018 Census and DIA birth records (as either child or parents of a child). An individual was recorded as a given Level 2 Pacific ethnicity if that ethnicity was stated across any of these records. In this

way, we combined data across the three highest-quality data sources on Level 2 ethnicity in the IDI, rather than relying solely on MOH records (used in the NZCR), which tend to under-count Level 2 Pacific ethnicities relative to the 2013 Census.<sup>19</sup> A total response approach to ethnicity was taken for all analysis, such that each individual is included in each ethnic group they belong to. The NZCR was further joined to border movements data to determine whether a person had a record of leaving the country within 1–5 years of receiving their diagnosis, without a death record. Because border movement data are only available from 1997, we opted to examine diagnoses from 1998 for mortality rates to enable easier comparison of rates when adjusting for those who had left the country.

Mortality was determined based on linked mortality records (available for the full 2022 year). As death diagnosis information was only available up to 2018, examination of 1–5-year cancer-specific mortality was limited to the 1995–2013 diagnosis cohort.

## Results

### All-cancer and gastric cancer incidence among specific Pacific ethnicities

For 1995–2022 all-cancer incidence among the 2008 APC Pacific populations shown in Table 1, the overall rate of 201.7 per 100,000 among Pacific peoples in general masks some variability in all-cancer incidence among specific Pacific groups. In particular, annual average age-standardised incidence per 100,000 was highest among Cook Islands Māori (217.5) and Tongans (217.7), and lowest among Tokelauan (192.4) and Fijian people (160.7; see top half of Table 1). (Note, however, that the Fijian ethnic group is coded from administrative data records, which tend to produce a large over-count of the Fijian group relative to the 2013 and 2018 Census. This may be due to the coding of Fijian Indians as Fijian rather than or in addition to Indian, and results for the Fijian group should therefore be interpreted with caution.) It is important to note that as these are diagnoses between 1998 and 2017 among the 2008 estimated resident population, higher incidence here is a product of both higher rates of occurrence as well as greater survival among those diagnosed prior to the denominator reference date (June 2008).

There was also variability in gastric cancer incidence among Level 2 Pacific groups (see lower half of Table 1). The overall rate of 8.0 per 100,000

among Pacific peoples in general masks the higher rate observed among those of Niuean (10.7 per 100,000) and Samoan (9.5 per 100,000) ethnicity, and lower rates among Cook Islands Māori (6.1 per 100,000) and Tokelauans (6.4 per 100,000). Similar patterns can be observed among men and women. Sex rate ratios indicated that men generally had higher gastric cancer incidence than women, with the highest men–women ratio of 1.9 among Tongans. However, there were few cases of gastric cancer among some Level 2 Pacific ethnicities (particularly Tokelauans) from 1995 to 2022, thus confidence intervals indicate considerable uncertainty in some of these estimates.

### All-cause mortality among 1998–2017 cancer cases

There was variation in all-cause mortality among the full cancer registry cohort (any diagnosis) across specific Pacific ethnicities. As shown in Table 2, 27% of Pacific peoples diagnosed with any cancer died within 1 year of their diagnosis, and 45% died within 5 years. However, 1-year mortality rates were higher for Tongan and Niuean people (31% and 32% respectively), and 5-year mortality rates were notably higher (48% and 51% respectively). Fijian people had clearly lower mortality across follow-up periods. Restricting cancer mortality analysis to only the aggregate Pacific group would mask this variation.

Examining all-cause mortality over time, rates had improved (decreased) for all Pacific ethnic groups in 2008–2017 compared with 1998–2007 (see Figure 1; underlying counts available in Appendix Table 1). For the overall Pacific group, mortality over a 1–5-year period was 6–7 percentage points lower in 2008–2017. Across Level 2 Pacific ethnic groups, there was some variability in mortality reduction. One-to-5-year mortality among Samoans decreased the most (by 8–9%). Reductions in mortality rates tended to be smaller for Cook Islands Māori (3–4%) and Tokelauans (0–4%).

Table 3 provides the counts of people diagnosed with any cancer from 1998 to 2017 and who left the country within 1–5 years of their first diagnosis (without subsequent records of return to the country or death records). The data indicate that rates of loss to follow-up through departures are generally low, but higher among Pacific peoples than the total cancer cohort. For Pacific peoples overall, 3.8% left the country within 5 years of their diagnosis (vs 1% of the total cases), but this was highest for Fijians (4.2%) and Samoans

**Table 1:** Average annual rates (all-cancer and gastric cancer) per 100,000 among Level 2 Pacific ethnicities in the 2008 APC diagnosed 1995–2022.

|                             | 2008 APC population | Total cancer cases | Annual crude rate per 100,000 | Age-standardised rates                         |                     |                     |                                 |
|-----------------------------|---------------------|--------------------|-------------------------------|--|---------------------|---------------------|---------------------------------|
|                             |                     |                    |                               | Total annual age-standardised rate per 100,000 | Men (95% CI)        | Women (95% CI)      | Rate ratio (Men: Women; 95% CI) |
| <b>Full cancer registry</b> |                     |                    |                               |  |                     |                     |                                 |
| Pacific                     | 340,560             | 13,134             | 137.7                         | 201.7 (198.2–205.1)                            | 198.7 (193.6–203.8) | 208.8 (204.0–213.6) | 1.0 (0.9–1.0)                   |
| Samoan                      | 161,031             | 5,991              | 132.9                         | 201.2 (196.1–206.3)                            | 198.2 (190.7–205.7) | 207.8 (200.7–214.8) | 1.0 (0.9–1.0)                   |
| Cook Islands Māori          | 67,836              | 2,511              | 132.2                         | 217.5 (209.0–226.0)                            | 215.6 (202.8–228.3) | 222.9 (211.3–234.5) | 1.0 (0.9–1.0)                   |
| Tongan                      | 64,554              | 2,349              | 130.0                         | 217.7 (208.9–226.5)                            | 205.4 (193.0–217.9) | 235.0 (222.3–247.8) | 0.9 (0.8–0.9)                   |
| Niuean                      | 25,476              | 879                | 122.8                         | 195.5 (182.5–208.4)                            | 204.6 (184.4–224.8) | 194.4 (177.0–211.7) | 1.1 (0.9–1.2)                   |
| Tokelauan                   | 6,963               | 240                | 123.0                         | 192.4 (168.1–216.8)                            | 178.4 (142.7–214.1) | 207.3 (173.8–240.8) | 0.9 (0.7–1.1)                   |
| Fijian                      | 27,195              | 987                | 129.6                         | 160.7 (150.7–170.8)                            | 165.9 (250.4–181.4) | 161.4 (147.9–174.9) | 1.0 (0.9–1.2)                   |
| Other Pacific               | 13,140              | 516                | 140.2                         | 206.1 (188.3–223.9)                            | 187.2 (162.1–212.4) | 224.8 (199.5–250.1) | 0.8 (0.7–1.0)                   |
| <b>Gastric cancer cases</b> |                     |                    |                               |  |                     |                     |                                 |
| Pacific                     | -                   | 492                | 5.2                           | 8.0 (7.3–8.7)                                  | 9.5 (8.3–10.6)      | 6.7 (5.8–7.6)       | 1.4 (1.2–1.7)                   |
| Samoan                      | -                   | 261                | 5.8                           | 9.5 (8.4–10.7)                                 | 11.2 (9.4–13.0)     | 8.2 (6.7–9.7)       | 1.4 (1.1–1.7)                   |
| Cook Islands Māori          | -                   | 72                 | 3.8                           | 6.1 (4.7–7.5)                                  | 7.4 (5.1–9.8)       | 5.0 (3.3–6.7)       | 1.5 (0.9–2.4)                   |
| Tongan                      | -                   | 84                 | 4.6                           | 7.8 (6.2–9.5)                                  | 10.5 (7.8–13.2)     | 5.4 (3.4–7.4)       | 1.9 (1.2–3.1)                   |
| Niuean                      | -                   | 45                 | 6.3                           | 10.7 (7.6–13.9)                                | 12.1 (7.3–16.9)     | 9.3 (5.3–13.3)      | 1.3 (0.7–2.3)                   |

**Table 1 (continued):** Average annual rates (all-cancer and gastric cancer) per 100,000 among Level 2 Pacific ethnicities in the 2008 APC diagnosed 1995–2022.

|               |                     |                    |                               | Age-standardised rates                         |                |                |                                 |
|---------------|---------------------|--------------------|-------------------------------|--|----------------|----------------|---------------------------------|
|               | 2008 APC population | Total cancer cases | Annual crude rate per 100,000 | Total annual age-standardised rate per 100,000 | Men (95% CI)   | Women (95% CI) | Rate ratio (Men: Women; 95% CI) |
| Tokelauan     | -                   | 6                  | 4.6                           | 6.4 (1.3–11.5)                                 | 4.0 (S–S)      | 7.8 (S–S)      | 0.5 (S–S)                       |
| Fijian        | -                   | 18                 | 2.4                           | 2.8 (1.5–4.1)                                  | 3.4 (1.2–5.6)  | 2.3 (0.8–3.8)  | 1.5 (0.6–3.7)                   |
| Other Pacific | -                   | 15                 | 4.1                           | 6.1 (3.0–9.1)                                  | 6.1 (2.1–10.0) | 5.9 (1.2–10.5) | 1.0 (0.4–2.9)                   |

APC = administrative population census; 95% CI = confidence interval; S = suppressed data due to counts under 6, in accordance with Stats NZ confidentiality requirements. Age-standardised to World Health Organization (2000–2025) Standard Population. Counts have been random rounded to base 3 according to Stats NZ Integrated Data Infrastructure confidentiality requirements. Crude rate based on rounded values. Age-standardised rates are based on unrounded values.

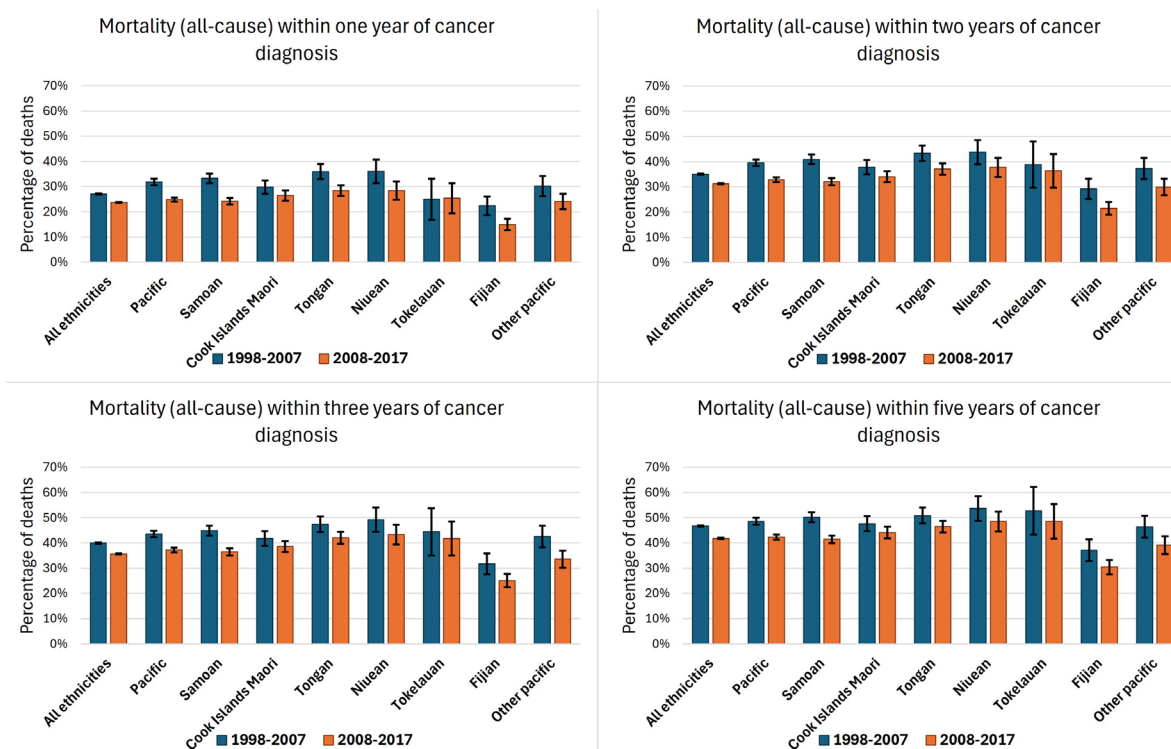
**Table 2:** One-to-5-year all-cause mortality rates for any diagnosed cancer from 1998 to 2017.

| <b>Ethnicity</b>   | <b>Individuals diagnosed</b> | <b>1-year mortality<br/>(95% CI)</b> | <b>2-year mortality<br/>(95% CI)</b> | <b>3-year mortality<br/>(95% CI)</b> | <b>5-year mortality<br/>(95% CI)</b> |
|--------------------|------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| All                | 370,518                      | 25.3 (25.1–25.4)                     | 33.0 (32.8–33.1)                     | 37.6 (37.5–37.8)                     | 44.1 (43.9–44.3)                     |
| Pacific            | 15,030                       | 27.4 (26.7–28.1)                     | 35.3 (34.6–36.1)                     | 39.6 (38.8–40.4)                     | 44.7 (43.9–45.5)                     |
| Samoaan            | 6,654                        | 27.6 (26.6–28.7)                     | 35.4 (34.2–36.5)                     | 39.6 (38.5–40.8)                     | 44.7 (43.5–45.9)                     |
| Cook Islands Māori | 2,937                        | 27.7 (26.1–29.3)                     | 35.4 (33.7–37.2)                     | 39.7 (38.0–41.5)                     | 45.5 (43.7–47.3)                     |
| Tongan             | 2,751                        | 31.1 (29.4–32.8)                     | 39.4 (37.5–41.2)                     | 44.0 (42.1–45.9)                     | 48.1 (46.2–50.0)                     |
| Niuean             | 1,017                        | 31.6 (28.7–34.4)                     | 40.1 (37.1–43.1)                     | 45.7 (42.7–48.8)                     | 50.7 (47.7–53.8)                     |
| Tokelauan          | 309                          | 25.2 (20.4–30.1)                     | 37.5 (32.1–42.9)                     | 42.7 (37.2–48.2)                     | 50.5 (44.9–56.1)                     |
| Fijian             | 1,497                        | 17.5 (15.5–19.4)                     | 24.0 (21.9–26.2)                     | 27.3 (25.0–29.5)                     | 32.5 (30.1–34.8)                     |
| Other Pacific      | 1,266                        | 26.3 (23.9–28.7)                     | 32.7 (30.1–35.3)                     | 37.0 (34.3–39.6)                     | 42.2 (39.5–44.9)                     |
| Realm              | 4,203                        | 28.6 (27.2–29.9)                     | 37.0 (35.5–38.4)                     | 41.6 (40.1–43.1)                     | 47.3 (45.8–48.8)                     |

95% CI = 95% confidence interval.

Realm includes New Zealand Realm country ethnicities (Cook Islands Māori, Niuean, Tokelauan).

**Figure 1:** All-cause mortality among all cancer cases diagnosed from 1998 to 2007 and 2008 to 2017. Error bars represent 95% confidence intervals.



**Table 3:** Counts of individuals diagnosed with any cancer between 1998 and 2017 and who left New Zealand within the specified follow-up period without ever returning or having a death record.

| Ethnicity          | Total diagnosed | Total who left without record of return or death within specified period |                       |                       |                       |
|--------------------|-----------------|--|-----------------------|-----------------------|-----------------------|
|                    |                 | 1-year post-diagnosis  | 2-year post-diagnosis | 3-year post-diagnosis | 5-year post-diagnosis |
| All                | 370,518         | 1,845 (0.5%)   | 2,499 (0.7%)          | 3,021 (0.8%)          | 3,810 (1.0%)          |
| Pacific            | 15,030          | 321 (2.1%)   | 417 (2.8%)            | 486 (3.2%)            | 573 (3.8%)            |
| Samoan             | 6,654           | 159 (2.4%)   | 198 (3.0%)            | 222 (3.3%)            | 267 (4.0%)            |
| Cook Islands Māori | 2,937           | 57 (1.9%)  | 78 (2.7%)             | 90 (3.1%)             | 108 (3.7%)            |
| Tongan             | 2,751           | 57 (2.1%)  | 69 (2.5%)             | 84 (3.1%)             | 96 (3.5%)             |
| Niuean             | 1,017           | 9 (0.9%)   | 9 (0.9%)              | 12 (1.2%)             | 18 (1.8%)             |
| Tokelauan          | 309             | 6 (1.9%)   | 9 (2.9%)              | 9 (2.9%)              | 12 (3.9%)             |
| Fijian             | 1,497           | 27 (1.8%)  | 42 (2.8%)             | 54 (3.6%)             | 63 (4.2%)             |
| Other Pacific      | 1,266           | 21 (1.7%)  | 27 (2.1%)             | 33 (2.6%)             | 39 (3.1%)             |
| Realm              | 4,203           | 72 (1.7%)  | 99 (2.4%)             | 114 (2.7%)            | 135 (3.2%)            |



**Table 4:** Difference (increase) in 1–5-year all-cause mortality rates for any diagnosed cancer from 1998 to 2017 after removing individuals who left the country during the follow-up period without record of return or death.

| Ethnicity          | 1-year mortality rate difference | 2-year mortality rate difference | 3-year mortality rate difference | 5-year mortality rate difference |
|--------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| All                | 0.1%                             | 0.2%                             | 0.3%                             | 0.5%                             |
| Pacific            | 0.6%                             | 1.0%                             | 1.3%                             | 1.8%                             |
| Samoan             | 0.7%                             | 1.1%                             | 1.4%                             | 1.9%                             |
| Cook Islands Māori | 0.5%                             | 1.0%                             | 1.2%                             | 1.7%                             |
| Tongan             | 0.7%                             | 1.0%                             | 1.4%                             | 1.7%                             |
| Niuean             | 0.3%                             | 0.5%                             | 0.7%                             | 0.8%                             |
| Tokelauan          | 0.8%                             | 0.9%                             | 1.3%                             | 1.6%                             |
| Fijian             | 0.3%                             | 0.7%                             | 1.0%                             | 1.5%                             |
| Other Pacific      | 0.4%                             | 0.7%                             | 1.0%                             | 1.3%                             |
| Realm              | 0.5%                             | 0.9%                             | 1.2%                             | 1.6%                             |

Percentage change reflects percentage point increase in mortality. Adjusted mortality rates with 95% confidence intervals are available in Appendix Table 2.

(4.0%), and lowest for Niueans (1.8%). As shown in Table 4, adjusting for those who left the country (who may be lost to follow-up and were therefore removed from the calculations) increased mortality percentages by only 0.1–1.9 points, with a larger difference over longer follow-up periods (as people are more likely to leave over longer periods of time).

### All-cause and cancer-specific mortality among gastric cancer cases

All-cause mortality among the gastric cancer cohort was reasonably consistent across specific Pacific ethnicities (see Table 5). All-cause mortality was slightly lower among Niueans and Fijians, although confidence intervals were larger among the cohort due to the smaller number of cases.

Mortality for the 1998–2007 and 2008–2017 diagnosis periods are displayed in Figure 2. For some ethnicities (e.g., Tokelauan), mortality cannot be presented due to low case counts that cannot be outputted from the IDI. For other smaller Pacific ethnic groups including Fijian, other Pacific and Niuean, low mortality counts over the different follow-up periods also mean the random rounding requirement for outputting

of counts has a larger effect on uncertainty in the mortality rate. To demonstrate this, plotted error bars represent random rounding uncertainty intervals based on the range of numerator and denominator values for each rate that could have been rounded to the outputted count. For example, there were 12 deaths among the Fijian gastric cohort over a 5-year follow-up period during 2008–2017 (see Appendix Table 3 for counts), but random rounding means this could reflect an unrounded value of anywhere between 10 and 14. Due to this effect of random rounding, caution should be taken when interpreting or comparing results for these smaller Pacific groups.

For the overall Pacific ethnic group, 1–5-year all-cause mortality decreased by approximately 3–9 percentage points in 2008–2017, relative to 1998–2007. Changes over time among Level 2 Pacific ethnicities, however, were mixed. For the largest Pacific ethnicities, all-cause mortality was consistently lower in 2008–2017 among Samoans. However, mortality was very similar, and often higher in 2008–2017 for Cook Islands Māori and Tongans, relative to 1998–2007 (but note the large overlap in confidence intervals). For Realm country ethnic groups combined (Cook Islands Māori,

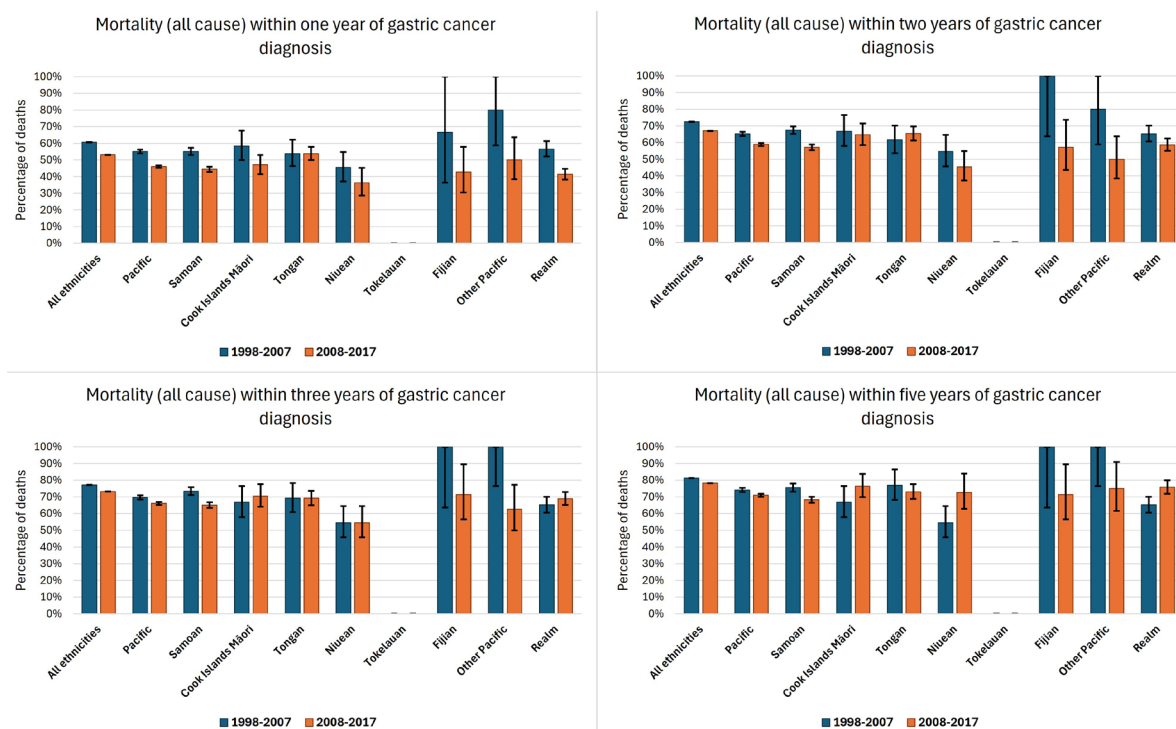


**Table 5:** One-to 5-year all-cause mortality rates for gastric cancer diagnoses from 1998 to 2017.

| <b>Ethnicity</b>   | <b>Individuals diagnosed</b> | <b>1-year mortality<br/>(95% CI)</b> | <b>2-year mortality<br/>(95% CI)</b> | <b>3-year mortality<br/>(95% CI)</b> | <b>5-year mortality<br/>(95% CI)</b> |
|--------------------|------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| All                | 7,686                        | 56.8 (55.7–57.9)                     | 69.6 (68.6–70.7)                     | 75.1 (74.2–76.1)                     | 79.8 (78.9–80.7)                     |
| Pacific            | 645                          | 49.3 (45.4–53.2)                     | 61.4 (57.6–65.2)                     | 67.0 (63.3–70.6)                     | 72.1 (68.6–75.6)                     |
| Samoaan            | 336                          | 49.1 (43.8–54.5)                     | 62.2 (57.0–67.3)                     | 67.9 (62.9–72.9)                     | 72.3 (67.5–77.1)                     |
| Cook Islands Māori | 90                           | 48.3 (38.0–58.6)                     | 62.1 (52.0–72.1)                     | 69.0 (59.4–78.5)                     | 73.3 (64.2–82.5)                     |
| Tongan             | 120                          | 51.2 (42.3–60.2)                     | 62.5 (53.8–71.2)                     | 67.5 (59.1–75.9)                     | 72.5 (64.5–80.5)                     |
| Niuean             | 63                           | 45.5 (33.2–57.8)                     | 54.5 (42.2–66.8)                     | 61.9 (49.9–73.9)                     | 66.7 (55.0–78.3)                     |
| Tokelauan          | 9                            | S                                    | S                                    | S                                    | S                                    |
| Fijian             | 36                           | 45.5 (29.2–61.7)                     | 54.5 (38.3–70.8)                     | 58.3 (42.2–74.4)                     | 66.7 (51.3–82.1)                     |
| Other Pacific      | 42                           | 57.1 (42.2–72.1)                     | 60.0 (45.2–74.8)                     | 71.4 (57.8–85.1)                     | 78.6 (66.2–91.0)                     |
| Realm              | 156                          | 47.1 (39.2–54.9)                     | 59.6 (51.9–67.3)                     | 66.0 (58.6–73.5)                     | 73.1 (66.1–80.0)                     |

95% CI = 95% confidence interval; S = suppressed data due to counts under 6, in accordance with Stats NZ confidentiality requirements.

**Figure 2:** All-cause mortality among gastric cancer cases diagnosed from 1998 to 2007 and 2008 to 2017. Note the error bars represent uncertainty intervals of estimates based on random rounding to base 3 for underlying counts—a requirement of Integrated Data Infrastructure data outputting.



Niuean, Tokelauan), 3- and 5-year mortality was also higher in 2008–2017, compared with 1998–2007.

Mortality rates where gastric cancer was the underlying cause of death are presented in Table 6. Although the data correspond to a different diagnosis period (1995–2013, due to the limited availability of cause of death data), these rates were generally similar to the all-cause mortality rates. The largest difference between all-cause and gastric cancer-specific mortality is for the Fijian group, who had among the lowest all-cause mortality rates but highest gastric cancer-caused mortality.

## Discussion

Using linked NZCR and administrative data, we identified variation in cancer incidence and outcomes among specific Pacific groups in New Zealand. Among the 2008 Pacific population, the overall 1995–2022 annual age-standardised cancer incidence of 202 per 100,000 masked higher incidence for Cook Islands Māori and Tongan ethnicities (218/100,00) in particular. The overall age-standardised gastric cancer rate of 8 per 100,000 also masked higher rates for Samoan

(10 per 100,000) and Niuean ethnicities (11 per 100,000). All-cause mortality was also higher for Tongan and Niuean ethnicities for all cancers diagnosed between 1998 and 2017 across 1–5-year follow-up periods. However, there tended to be less variation in all-cause mortality among the gastric cancer cohort, with slightly lower mortality for Niuean ethnicity.

All-cause mortality for all cancers was around 6 percentage points lower in 2008–2017 compared with 1998–2007, regardless of follow-up period, with the largest decrease occurring for Samoan ethnicity (approximately 9 percentage point reduction). Changes in all-cause mortality among gastric cancer cases was more variable, but with the largest reductions again seen for Samoan ethnicity. In some cases, all-cause mortality increased in the 2008–2017 period; however, this may be due to smaller sample sizes when examining rates among a narrower diagnosis period. Random rounding required for outputting IDI data has much larger effects on small counts, creating a significant challenge in providing reliable, detailed health data for small populations. It will be important to find solutions to this challenge, such as case-by-case exceptions by

**Table 6:** One-to-5-year mortality rates for gastric cancer diagnoses from 1995 to 2013 where gastric cancer was the underlying cause of death.

| <b>Ethnicity</b>   | <b>Individuals diagnosed</b> | <b>1-year mortality<br/>(95% CI)</b> | <b>2-year mortality<br/>(95% CI)</b> | <b>3-year mortality<br/>(95% CI)</b> | <b>5-year mortality<br/>(95% CI)</b> |
|--------------------|------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| All                | 7,251                        | 59.7 (58.6–60.9)                     | 71.9 (70.9–72.9)                     | 77.2 (76.3–78.2)                     | 81.5 (80.7–82.4)                     |
| Pacific            | 552                          | 51.6 (47.5–55.8)                     | 63.9 (59.9–67.9)                     | 69.2 (65.3–73.0)                     | 73.4 (69.7–77.1)                     |
| Samoaan            | 288                          | 49.5 (43.7–55.3)                     | 62.5 (56.9–67.9)                     | 69.1 (63.7–74.4)                     | 71.9 (66.7–77.1)                     |
| Cook Islands Māori | 78                           | 53.8 (42.8–64.9)                     | 65.4 (54.8–75.9)                     | 69.2 (59.0–79.5)                     | 73.1 (63.2–82.9)                     |
| Tongan             | 99                           | 51.5 (41.7–61.4)                     | 64.7 (55.3–74.1)                     | 69.7 (60.6–78.7)                     | 75.8 (67.3–84.2)                     |
| Niuean             | 57                           | 52.6 (39.7–65.6)                     | 63.2 (50.6–75.7)                     | 68.4 (56.4–80.5)                     | 73.7 (62.3–85.1)                     |
| Tokelauan          | S                            | S                                    | S                                    | S                                    | S                                    |
| Fijian             | 27                           | 60.0 (41.5–78.5)                     | 66.7 (48.9–84.4)                     | 75.0 (58.7–91.3)                     | 77.8 (62.1–93.5)                     |
| Other Pacific      | 42                           | 53.3 (38.2–68.4)                     | 57.1 (42.2–72.1)                     | 66.7 (52.4–80.9)                     | 78.6 (66.2–91.0)                     |
| Realm              | 135                          | 54.5 (46.1–62.9)                     | 66.7 (58.7–74.6)                     | 70.5 (62.8–78.2)                     | 75.6 (68.3–82.8)                     |

95% CI = 95% confidence interval; S = suppressed data due to counts under 6, in accordance with Stats NZ confidentiality requirements.

Stats NZ, to investigate questions that can only be addressed using linked administrative data.

It is important to note that we counted all cases in each specific Pacific group reported. Thus, although differences can be observed between ethnic groups, they cannot be formally statistically compared as individuals reporting multiple Pacific ethnicities mean the groups are not mutually exclusive. There are also issues of data quality of ethnicity collection to bear in mind. In particular, age-standardised gastric cancer incidence and gastric cancer mortality appeared lower among the Fijian group compared to other Pacific ethnicities. However, previous work has identified an over-count of the Fijian group in administrative data sources compared with the Census.<sup>18,19</sup> The standard classification of ethnicity requires Fijian Indian ethnicity to be coded as Indian (under the Level 1 Asian ethnic category) rather than Fijian (under the Level 1 Pacific category), but evidence suggests Fijian Indian ethnicity is often recorded as Fijian or both Fijian and Indian, leading to an over-count of the Fijian group.<sup>19,20</sup> This makes it difficult to determine whether our results reflect true differences or are influenced by coding errors in the administrative data sources and reinforces the importance of adhering to data collection and ethnicity classification standards when coding data. Despite this, we used consistent sources of information on ethnicity for numerator and denominator data where necessary, removing the impact of numerator–denominator bias.

By analysing linked data in the IDI we were able to quantify the extent of emigration from New Zealand following cancer diagnosis and what effect this might have on mortality estimates. Although we identified higher rates of loss to follow-up emigration (i.e., records of an individual leaving the country without return or record of death) among Pacific peoples (3.8% of those diagnosed from 1998 to 2017 within a 5-year period, compared with 1.0% of diagnosed individuals in general), these generally had only small effects on basic mortality rates of within 0–2 percentage points (with a larger impact on longer follow-up periods). Nonetheless, we demonstrate methods developed for detailed analyses for the Pacific population that consider these important factors.<sup>18</sup>

Samoan and Tongan people have been previously theorised to be most likely to exhibit return migration than other Level 2 Pacific ethnic groups as they are less likely to be born in New Zealand and Tonga and Samoa have more substantial health service infrastructure than other island nations.<sup>11</sup> It is also possible that ethnicities associated with Realm countries (Cook Islands, Niue, Tokelau) may have higher rates of loss to follow-up if they travelled to New Zealand specifically for health-care. Our results show loss to follow-up was most common for Samoans and Fijians (4.0% and 4.2% respectively over a 5-year post-diagnosis period). Cook Islands Māori and Tokelauans (i.e., those associated with Realm nations) also had relatively high rates of return migration, but Niueans had the lowest (1.8%). Relatedly, travel by Realm-nation citizens to New Zealand could also inflate the incidence for those ethnicities in New Zealand. However, there is currently no information in the NZCR or IDI that indicates for whom that is the case.

Overall, the findings emphasise the importance of generating key cancer statistics for specific Pacific ethnic groups in New Zealand. The IDI provides a useful tool for examining issues that are beyond the scope of the NZCR alone. However, data confidentiality rules for outputting data from the IDI (suppression of counts under 5, and random rounding of all counts) mean basic incidence and mortality rates would be best produced routinely from the NZCR outside the IDI, especially where differences in incidence and outcomes are identified for specific Pacific ethnicities. Analysis of the NZCR outside the IDI would also enable more timely production of data, as data in the IDI is updated roughly four times a year, with collections such as the NZCR being updated less frequently (e.g., data to the end of 2022 were available in the October 2023 IDI refresh). Future research should continue to examine where cancer incidence and outcomes differ between specific Pacific (and other ethnic) groups to enable improved surveillance for these groups. This may be particularly beneficial for more common cancers, such as breast, prostate or lung, for example.<sup>6</sup>

**COMPETING INTERESTS**

Nil.

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**DISCLAIMERS**

Access to the data used in this article was provided by Stats NZ under conditions designed to give effect to the security and confidentiality provisions of the *Data and Statistics Act 2022*. The results presented in this report are the work of the authors, not Stats NZ or individual data suppliers.

These results are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI), which is carefully managed by Stats NZ. For more information about the IDI please visit <https://www.stats.govt.nz/integrated-data/> Data in this article have been reported in accordance with Stats NZ's confidentiality rules for microdata use, and as such random rounding to the base 3 has been applied to all count data and counts of 5 or less have been suppressed (S).

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**Appendix Table 1:** All cancer diagnoses and deaths (all-cause) by 10-year diagnosis period.

| Ethnicity             | 1998–2007 cancer diagnoses |               |               |               |               | 2008–2017 cancer diagnoses |               |               |               |               |
|-----------------------|----------------------------|---------------|---------------|---------------|---------------|----------------------------|---------------|---------------|---------------|---------------|
|                       | N Diagnosed                | 5-year deaths | 3-year deaths | 2-year deaths | 1-year deaths | N Diagnosed                | 5-year deaths | 3-year deaths | 2-year deaths | 1-year deaths |
| All                   | 170,625                    | 79,776        | 68,190        | 59,793        | 46,254        | 199,893                    | 83,634        | 71,292        | 62,391        | 47,448        |
| Pacific               | 5,571                      | 2,709         | 2,427         | 2,208         | 1,773         | 9,453                      | 4,002         | 3,522         | 3,108         | 2,349         |
| Samoaan               | 2,499                      | 1,254         | 1,122         | 1,023         | 831           | 4,155                      | 1,722         | 1,515         | 1,332         | 1,008         |
| Cook Islands<br>Māori | 1,095                      | 522           | 459           | 414           | 327           | 1,842                      | 813           | 711           | 627           | 489           |
| Tongan                | 996                        | 507           | 471           | 432           | 357           | 1,755                      | 816           | 738           | 651           | 498           |
| Niuean                | 408                        | 219           | 201           | 177           | 147           | 612                        | 297           | 264           | 231           | 174           |
| Tokelauan             | 108                        | 57            | 48            | 42            | 27            | 204                        | 99            | 84            | 72            | 51            |
| Fijian                | 492                        | 183           | 156           | 144           | 111           | 1,005                      | 306           | 252           | 216           | 150           |
| Other Pacific         | 504                        | 234           | 216           | 189           | 153           | 759                        | 297           | 255           | 228           | 183           |
| Realm                 | 1,593                      | 795           | 702           | 630           | 498           | 2,613                      | 1,194         | 1,047         | 924           | 705           |

Random rounding to base 3 has been applied to all values in this table.



**Appendix Table 2:** One-to-5-year all-cause mortality rates for any diagnosed cancer from 1998 to 2017 after removing individuals who left the country during the follow-up period without record of return or death.

| <b>Ethnicity</b>   | <b>Individuals diagnosed</b> | <b>5-year mortality rate<br/>(proportion, 95% CI)</b> | <b>3-year mortality rate<br/>(proportion, 95% CI)</b> | <b>2-year mortality rate<br/>(proportion, 95% CI)</b> | <b>1-year mortality rate<br/>(proportion, 95% CI)</b> |
|--------------------|------------------------------|---|---|---|---|
| All                | 366,708                      | 44.6 (44.4–44.7)                                      | 38.0 (37.8–38.1)                                      | 33.2 (33.0–33.4)                                      | 25.4 (25.3–25.6)                                      |
| Pacific            | 14,454                       | 46.4 (45.6–47.2)                                      | 40.9 (40.1–41.7)                                      | 36.4 (35.6–37.1)                                      | 28.0 (27.3–28.8)                                      |
| Samoaan            | 6,387                        | 46.6 (45.4–47.8)                                      | 41.0 (39.8–42.2)                                      | 36.5 (35.3–37.7)                                      | 28.3 (27.2–29.4)                                      |
| Cook Islands Māori | 2,826                        | 47.1 (45.3–49.0)                                      | 40.9 (39.1–42.8)                                      | 36.4 (34.6–38.2)                                      | 28.2 (26.5–29.9)                                      |
| Tongan             | 2,652                        | 49.8 (47.9–51.7)                                      | 45.4 (43.5–47.3)                                      | 40.4 (38.5–42.2)                                      | 31.8 (30.0–33.5)                                      |
| Niuean             | 1,002                        | 51.5 (48.4–54.6)                                      | 46.4 (43.3–49.5)                                      | 40.6 (37.6–43.6)                                      | 31.8 (29.0–34.7)                                      |
| Tokelauan          | 294                          | 52.0 (46.3–57.8)                                      | 44.0 (38.3–49.7)                                      | 38.4 (32.8–43.9)                                      | 26.0 (21.0–31.0)                                      |
| Fijian             | 1,431                        | 34.0 (31.5–36.4)                                      | 28.3 (25.9–30.6)                                      | 24.8 (22.6–27.0)                                      | 17.8 (15.8–19.7)                                      |
| Other Pacific      | 1,227                        | 43.5 (40.7–46.3)                                      | 38.0 (35.2–40.7)                                      | 33.4 (30.8–36.1)                                      | 26.7 (24.3–29.2)                                      |
| Realm              | 4,068                        | 48.9 (47.4–50.4)                                      | 42.8 (41.3–44.3)                                      | 37.8 (36.3–39.3)                                      | 29.1 (27.7–30.5)                                      |

Random rounding to base 3 has been applied to all values in this table.

95% CI = 95% confidence interval.

**Appendix Table 3:** Stomach cancer diagnoses and deaths (all-cause) by 10-year diagnosis period.

| Ethnicity             | 1998–2007 gastric cancer diagnoses |               |               |               |               | 2008–2017 gastric cancer diagnoses |               |               |               |               |
|-----------------------|------------------------------------|---------------|---------------|---------------|---------------|------------------------------------|---------------|---------------|---------------|---------------|
|                       | N Diagnosed                        | 5-year deaths | 3-year deaths | 2-year deaths | 1-year deaths | N Diagnosed                        | 5-year deaths | 3-year deaths | 2-year deaths | 1-year deaths |
| All                   | 3,816                              | 3,105         | 2,943         | 2,763         | 2,313         | 3,867                              | 3,027         | 2,832         | 2,589         | 2,052         |
| Pacific               | 267                                | 198           | 186           | 174           | 147           | 372                                | 264           | 246           | 219           | 171           |
| Samoaan               | 147                                | 111           | 108           | 99            | 81            | 189                                | 129           | 123           | 108           | 84            |
| Cook Islands<br>Māori | 36                                 | 24            | 24            | 24            | 21            | 51                                 | 39            | 36            | 33            | 24            |
| Tongan                | 39                                 | 30            | 27            | 24            | 21            | 78                                 | 57            | 54            | 51            | 42            |
| Niuean                | 33                                 | 18            | 18            | 18            | 15            | 33                                 | 24            | 18            | 15            | 12            |
| Tokelauan             | S                                  | S             | S             | S             | S             | 9                                  | S             | S             | S             | S             |
| Fijian                | 9                                  | 9             | 9             | 9             | 6             | 21                                 | 15            | 15            | 12            | 9             |
| Other Pacific         | 15                                 | 15            | 15            | 12            | 12            | 24                                 | 18            | 15            | 12            | 12            |
| Realm                 | 69                                 | 45            | 45            | 45            | 39            | 87                                 | 66            | 60            | 51            | 36            |

Random rounding to base 3 has been applied to all values in this table.

S = suppressed data due to counts under 6, in accordance with Stats NZ confidentiality requirements.